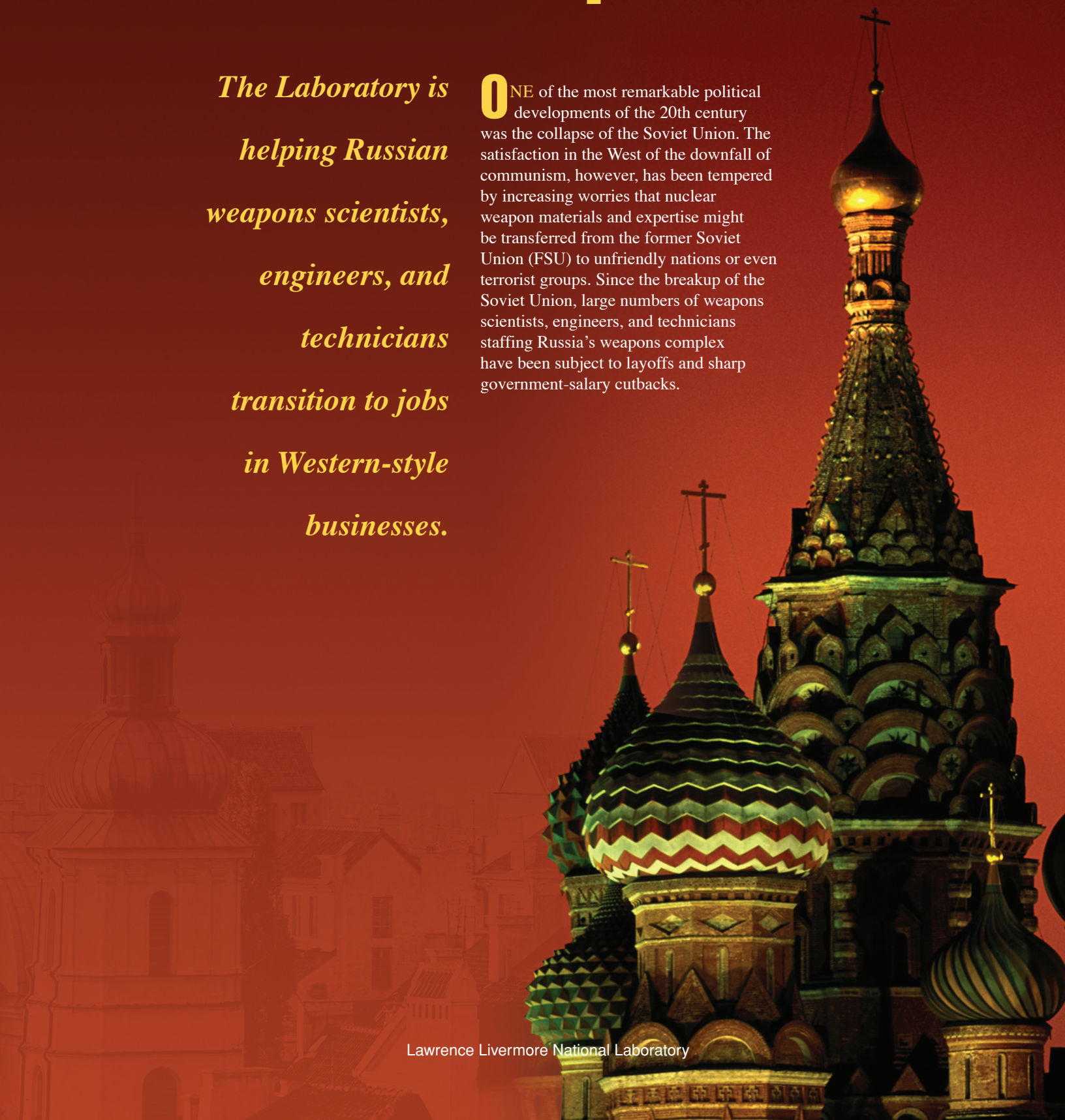
Russian Weapons Workers

The Laboratory is helping Russian weapons scientists, engineers, and technicians transition to jobs in Western-style businesses.

ONE of the most remarkable political developments of the 20th century was the collapse of the Soviet Union. The satisfaction in the West of the downfall of communism, however, has been tempered by increasing worries that nuclear weapon materials and expertise might be transferred from the former Soviet Union (FSU) to unfriendly nations or even terrorist groups. Since the breakup of the Soviet Union, large numbers of weapons scientists, engineers, and technicians staffing Russia's weapons complex have been subject to layoffs and sharp government-salary cutbacks.



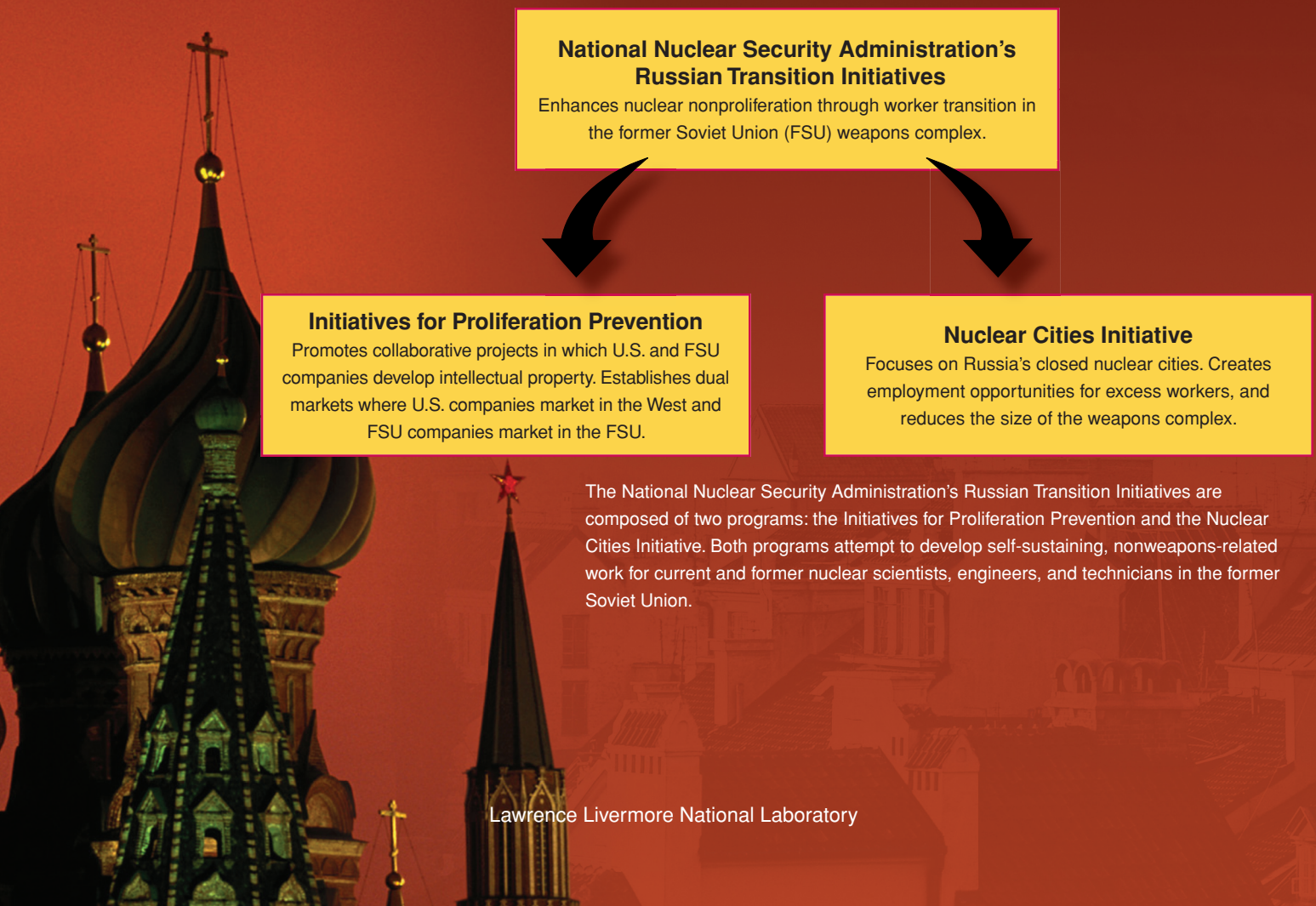
Begin New Commercial Venture

In response to the nuclear proliferation danger, the Department of Energy's (DOE's) National Nuclear Security Administration (NNSA) created nonproliferation programs focused on the states of the FSU. "We want to keep workers in the FSU with nuclear expertise employed by helping them create viable jobs in the high-technology sector," says Livermore seismologist Jay Zucca, a leader in the Laboratory's Proliferation and Terrorism Prevention Program, which is part of the Nonproliferation, Arms Control, and International Security Directorate.

NNSA's Russian Transition Initiatives are composed of two programs: the Initiatives for Proliferation Prevention (IPP) and the Nuclear Cities Initiative (NCI). Both programs attempt to develop self-sustaining, nonweapons work for current and former weapons scientists, engineers, and technicians. Zucca notes that Livermore's long-standing knowledge of FSU nuclear facilities and its scientists makes the Laboratory an excellent resource for both FSU scientists and American companies interested in forging partnerships.

Established in 1994, the IPP promotes collaborative projects among DOE national laboratories, U.S. private-industry partners, and institutes in the FSU. Projects are selected for their commercial potential and are designed to lead to long-term employment in the civilian sector for former weapons workers.

The NCI was established in 1998 under a government-to-government agreement to help Russia reduce the size of its nuclear weapons complex, which is about three times the size of the U.S. complex. The NCI is active in three of Russia's ten "closed" nuclear cities—Sarov, Seversk, Snezhinsk—and is planning to work with a fourth, Zheleznogorsk. These closed cities have populations ranging from 30,000 to



The National Nuclear Security Administration's Russian Transition Initiatives are composed of two programs: the Initiatives for Proliferation Prevention and the Nuclear Cities Initiative. Both programs attempt to develop self-sustaining, nonweapons-related work for current and former nuclear scientists, engineers, and technicians in the former Soviet Union.

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120,000. Until about 15 years ago, Western researchers were not allowed to visit them. In fact, the cities were not even on maps.

Livermore participates in both the IPP and NCI programs. Zucca notes that there is not a strict division in activities between the two programs. For example, more than 25 percent of the IPP's activities take place in Russia's closed nuclear cities.

Role of the IPP

The IPP creates new jobs through projects that commercialize expertise and products in FSU scientific institutes involved in weapons technologies. Today, 11 organizations belonging to DOE are involved in the IPP program—10 national laboratories and NNSA's Kansas City Plant. Almost two dozen Livermore workers, mostly engineers, are involved in about 20 different IPP projects.

"The IPP is the broker between the Russians and private industry," says Don Lesuer, a materials engineer and program manager for the Livermore IPP. "We validate what the Russians are doing, and that gives their technical expertise and products credibility to American firms. These firms are recognizing the possible business and technical advantages of developing concepts and prototypes in the FSU."

Since its inception, the IPP program has funded more than 750 projects involving more than 15,000 weapons scientists, engineers, and technicians at more than 200 institutes in Russia, Ukraine, Kazakhstan, Georgia, Uzbekistan, and Armenia. American companies match U.S. government funds to develop and commercialize projects that are not military-related. Seventy percent of these funds is spent in the FSU, and 30 percent is spent in the U.S. for technical contributions and project management.

Two entities carefully review proposed commercialization projects. The Inter-Laboratory Board, whose members are from the national laboratories and the Kansas City Plant, reviews the proposals generated by DOE laboratories for technical content and economic viability. The U.S. Industry Coalition evaluates the commercial viability of proposed projects. NNSA gives final approval before a project is funded.

An Initiatives for Proliferation Prevention project is developing pain-blocking devices that use low-level electrical pulses. A wireless device (shown here) won an R&D 100 Award for being one of the most important industrial inventions in 2002. Livermore scientists partnered with the U.S. firm Cyclotec and the Russian firm Biofil to develop and miniaturize the control module (inset) for the device.

Focus on Medical Technology

Several IPP projects involving Livermore and a U.S. private-industry partner focus on medical technology and biological research. One project is developing pain-blocking devices that use low-level electrical pulses. The Russian firm is Biophysical Laboratory (Biofil) Ltd., a company spun off from the All-Russian Research Institute of Experimental Physics in Sarov. Biofil conducts research and development on biomedical devices. The U.S. partner is Cyclotech Advanced Medical Technologies (Cyclotech), Inc.

The partners formed a joint cooperative research agreement to develop the advanced, easy-to-use pain-blocking device. The device won an R&D 100 Award for being one of the most important industrial inventions in 2002. (See *S&TR*, October 2002, pp. 12–13.) Livermore scientists partnered with Cyclotec and Biofil to develop and miniaturize a control module for the device.

Another project involving Biofil focuses on a breast cancer probe that resulted from work done at Livermore in its Medical Technology Program. Russian researchers are developing data-analysis algorithms and software for a probe that uses the electrical and optical properties of tissue to identify malignant tumors in the breast.

The project, which began in 2004, is one of the first to be sponsored jointly by the IPP and NCI programs.

"Because of the work that Biofil has done with Livermore, the company is making significant strides to becoming a self-sustaining business," says Lesuer. Biofil has received more than $350,000 from several U.S. biomedical companies for research and development on biomedical devices.

A project that began in 2003 involves collaborative work between Livermore and the National Center for Disease Control (NCDC) in Tbilisik, Georgia. This project, which is relevant to U.S. counterterrorism efforts, conducts molecular fingerprinting and DNA decoding of strains of *Yersinia pestis* and *Francisella tularensis*, the bacteria that cause plague and tularemia, respectively. DNA from strains at NCDC was transferred to Livermore for study, and, in August 2003, two NCDC scientists worked at Livermore to learn DNA decoding.

Another IPP project focuses on commercializing a Russian device called an alternating current (ac) plasma torch to completely destroy hazardous and medical waste. Participating Russian institutes include the Institute for Problems of Electrophysics and Soliton-NTT (a spin-off company of Russia's Kurchatov Institute). The U.S. private-industry partner is Scientific Utilization of Huntsville, Alabama. The torch is a commercial version of a waste destruction system used by the Russians for a number of applications, including the destruction of chemical weapons and bioagents. The device being developed under the IPP program is intended for destroying medical waste. It creates plasma temperatures between 2,500 and 6,000 kelvins and can process 150 kilograms of waste per hour.

Three ac plasma torches and power supplies were manufactured in Russia and sent to the U.S. for evaluation. Livermore contributions included studying the electrode materials and evaluating torch performance. Plans are under way for the first Russian medical waste plant in St. Petersburg, which will use the ac plasma torch. Livermore scientists, in collaboration with the County of Alameda in California, have submitted a proposal for a waste disposal plant that would generate 20 megawatts of power while destroying 500 tons of municipal waste a day. The plant design would use high-temperature gases produced by the plasma torch for the co-generation of electricity.

In another IPP project, Livermore is teaming with Cryocarbon (another spin-off company of Russia's Kurchatov Institute), the Polish Academy of Sciences' Institute of Molecular Physics, and Spectra Gases of New Jersey to design and produce isotope-manufacturing facilities at Kurchatov. The project is developing facilities to manufacture two isotopes, carbon-13 and oxygen-18. Carbon-13 is used for labeling urea and glucose as markers of medical conditions, such as ulcers and diabetes. Applications for oxygen-18 include medical diagnostic imaging, such as positron emission tomography imaging, and medical research studies.

At the project's start, Kurchatov had no experience in the production of these medical isotopes. To aid this effort, Livermore applied its technical expertise in isotope separation technologies and complex systems analysis. Full production of isotopes began in December 2004. At the project's conclusion, the goal is for Kurchatov weapon scientists and engineers to be permanently employed producing the isotopes and developing and marketing other labeled compounds derived from carbon-13 and oxygen-18.

Launching Commercial Products

One of the most promising IPP projects involves manufacturing and evaluating advanced aircraft and space-launched vehicle components. The project teams Livermore, Boeing, and five institutes in Russia and Ukraine for the study of advanced Russian metal-forming and welding technologies and their possible application to Boeing products.

As part of the IPP project, prototype cryogenic tanks for a Boeing Delta-series launch vehicle and airplane fuselage sections were fabricated and sent to Livermore for analysis. In October 2003, Boeing representatives visited the Laboratory to study the hardware and discuss the application of Russian manufacturing technologies to future Boeing products.

Boeing is studying the possibility of establishing a permanent manufacturing capability in the FSU for next-generation aircraft parts. Lesuer says a manufacturing

Livermore is teaming with Cryocarbon, a spin-off company from Russia's Kurchatov Institute, and Spectra Gases of New Jersey to design and produce manufacturing facilities for two medical isotopes, carbon-13 and oxygen-18. Shown here are distillation columns at Kurchatov for manufacturing carbon-13.

plant could employ hundreds of scientists, engineers, and technicians.

Several IPP projects exploit Russian expertise in high explosives. One effort is developing a rarefaction shock-wave cutter for removing offshore oil and gas platforms at the end of their useful lives. The cutter uses special explosives technology to cut thick-walled pipes. The device can be deployed without divers, and its explosive impacts are less damaging to marine life than current technology. Halliburton Energy Services Inc. has entered into a commercialization option agreement with scientists from the All-Russian Institute of Experimental Physics in Sarov. "This IPP project has been a resounding success," says Lesuer.

In 2004, work began on a project to develop and evaluate an explosives detection system for use on checked airline baggage and cargo. The project is a collaborative effort between five Russian institutes, Livermore, and Valley Forge Composites of King of Prussia, Pennsylvania. The explosives detection system is based on a small-scale accelerator developed by P. N. Lebedev Physical Institute, the lead Russian partner. The device analyzes gamma radiation resulting from photonuclear reactions in explosive compounds. Livermore engineers will be evaluating the accelerator and system performance.

"Through these projects, the Russians learn what it takes to launch a Western-style commercial project. They're also understanding the need to keep costs low to stay competitive," says Lesuer.

Opening Closed Nuclear Cities

Since 1999, NNSA and the Federal Atomic Energy Agency (formerly the Russian Ministry of Atomic Energy) have jointly implemented the NCI program. Their objective is to reduce Russia's enormous nuclear weapons complex by helping former weapons experts in closed nuclear cities make the transition to civilian employment.

The program's primary focus was on three closed cities: Sarov, Snezhinsk, and Zheleznogorsk. These cities were formerly known by the mailing addresses of nearby cities: Arzamas-16, Chelyabinsk-70, and Krasnoyarsk-26, respectively.

Sarov is the site of the All-Russian Research Institute for Experimental Physics (VNIIEF), which was Russia's first nuclear weapons laboratory, and the Avangard weapons assembly plant.

Snezhinsk is the home of the All-Russian Research Institute for Technical Physics (VNIITF), which was Russia's second nuclear weapons laboratory. Zheleznogorsk is home to the Mining and Chemical Combine, which is one of Russia's three plutonium production complexes. In Zheleznogorsk, the NCI is supporting Russian efforts to shut down the plutonium production reactors.

Both the VNIIEF in Sarov and the VNIITF in Snezhinsk have identified scientists, engineers, and technicians with special weapons design knowledge who will be released from their institutes over the next few years. The NCI is working to convert their government jobs to ones

Prototype cryogenic tanks are manufactured in Russia as part of an Initiatives for Proliferation Prevention project involving five Russian institutes, Lawrence Livermore, and Boeing. Livermore and Boeing workers are shown with the tanks at Livermore.

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in commercial companies. Lawrence Livermore is a key national laboratory for NCI projects in Snezhinsk, which is the sister city to Livermore, California.

According to Livermore NCI program manager Ann Heywood, the program develops physical and business infrastructure in the cities, helps establish sustainable enterprises, creates good jobs, and advances Russian business development and diversification. The goal is a smaller Russian weapons complex and increased U.S. and international security. Private U.S. businesses often participate in projects, but their participation is not required, as it is with IPP projects.

In 1999, an important NCI project began when Livermore helped create the Open Computing Center in Snezhinsk for commercial computing and software development. The project was attractive to NCI managers because of Russian computer programming expertise and the small capital investment required. A modern, permanent facility was completed in 2003; two-thirds was paid for by the VNIITF and the remaining third by NCI.

As the center grew, it was renamed STRELA, which means "arrow" in Russian and is the name of the first computer that operated in the Urals. Livermore helped STRELA obtain U.S. Department of Commerce approval for acquiring the center's principal computer, an American-made Linux cluster. The computer has 20 nodes, each containing two Intel Pentium-4 microprocessors connected by high-bandwidth Infiniband networking.

In addition, the Russians adopted Western companies' best practices for data protection and archiving. STRELA currently employs about 60 programmers. "They find most of the software projects just as challenging as their old weapons-related work," says Livermore physicist Dale Nielsen, Jr., who has helped oversee STRELA's development.

Although STRELA initially worked on a large set of projects, it now focuses on five commercialization efforts. For example, the company is the sole official distributor in Russia for LS-DYNA, a software product of Livermore Software Technology Corporation. The code is a commercial version of DYNA, which was developed at Livermore, and has evolved into the world standard for simulating vehicle crashes. STRELA sells licenses to other companies and does consulting work. Nielsen explains that Russian car companies are modifying their designs to meet European Union standards for crash-worthiness, so they need better simulation software and expertise. Livermore has trained STRELA engineers to use the code.

STRELA also operates a document-processing center to help institutions digitize paper-based data, such as card catalogs in Russian libraries. The NCI program helped STRELA to obtain high-end scanning equipment, storage devices, and software to efficiently convert paper documents to electronic files. "There is a

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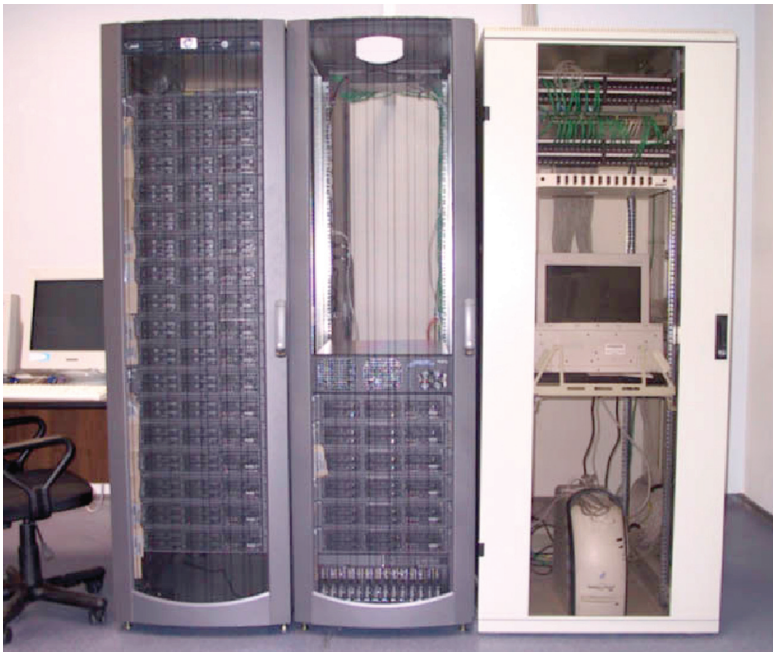


The STRELA company in Snezhinsk employs about 60 programmers who work on commercial computing and software development. Livermore helped the center acquire its Linux cluster computer, which consists of 20 computing nodes.

At the Spektr-Conversion company, the oil-well perforator business is growing. (a) A final inspection of a perforator is performed before field-testing in Russian oil fields. (b) The successful field tests led to the first commercial production of perforators.

tremendous business potential in Russia for this kind of work," says Nielsen.

A similar effort involves working with the Association of Small and Medium-Size Towns in Russia to help cities manage their official data. STRELA has partnered with the Russian firm ARSINT for sales, installation, and support of technology to transfer data electronically.

The NCI program is also helping Spektr-Conversion, a growing engineering services company of 50 employees who formerly worked on nuclear weapons at the All-Russian Scientific Research Institute of Technical Physics in Snezhinsk. Spektr-Conversion engineers have developed advanced oil-well perforators.

The perforators use shaped charges to fracture the surrounding rock and allow the liberation and extraction of more oil and gas. Tests conducted in December 2003 showed the perforators outperformed other units of both Russian and Western design. Livermore and Spektr-Conversion jointly designed the perforator, charges, detonators, and metal parts.

Last year, the company produced its first 160 units, and their goal is 20,000 units per year. The company's products also include custom auto parts, a dynamic wheelchair device, and electronic knee prostheses. Their business plan forecasts the creation of more than 230 jobs in three years. "Spektr-Conversion is becoming comparable to major companies, such as Halliburton, in product design," says Heywood.

Imaging Technology Shows Promise

One notable NCI-supported project in the FSU is a positron emission tomography (PET) center being established with Snezhinsk scientists. PET is an imaging technology for diagnosing cancer. It uses sugars tagged with isotopes, which are injected into a patient. These glucose molecules preferentially flow to tumors because of their extensive vascular systems. Because a PET scan shows where

glucose molecules concentrate, it is a sensitive indicator for tumors.

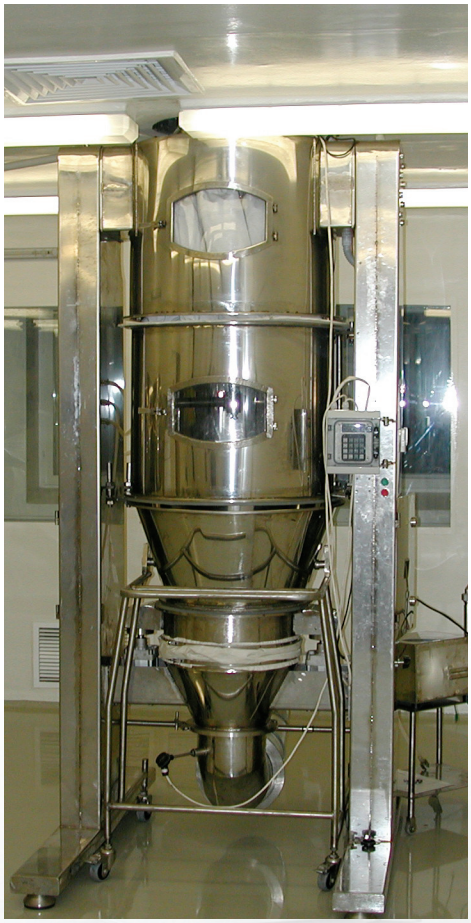
Livermore formed a PET team that includes the Biomedical Research Foundation of Northwest Louisiana, the VNIITF in Snezhinsk, and the Chelyabinsk Oblast Oncology Center. Livermore helped create a strong business model that included a market analysis. The NCI program is funding the building of a major PET center in Snezhinsk. The facility should provide high-tech employment for many scientists and engineers who have imaging science, accelerator, and chemical expertise.

This project has strong support from Russian authorities. Because many health problems in the area have been attributed to the nuclear weapons industry, local governments have a keen interest in diagnosing and treating cancer. Russian medical experts estimate that the PET center, which would be the only such center in the Urals, could reduce surgeries by 30 percent.

Heywood says the project will benefit many people in the area and generate significant revenue. Project planners are discussing the installation of PET scanners in other cities in the Urals and providing PET consulting to other cities and regions.

In another health-related project, Livermore is helping to bring cost-effective antibiotics to the Urals. Previously, the Snezhinsk Pharmaceutical Company was repackaging drugs to distribute to regional hospitals and physicians. Because the NCI program was able to procure machinery for the company that gave them the capacity to form pills from bulk materials, the company is now selling antibiotics in pill form across the Urals and working on contracts to supply developing nations.

Heywood notes that no single business model for NCI projects exists. Joint ventures, not-for-profit centers, companies formed directly out of a laboratory, and partnerships with the West can all be successful. She also says that the NCI program is changing its focus to those cities where plutonium reactors are shutting down, such as Zheleznogorsk and Seversk. Livermore has a 12-year relationship with Seversk and is coordinating an effort to develop catalysts from uranium oxide. The pilot plant and the anticipated manufacturing plant will be located at Seversk's Siberian Chemical Combine. Additional funding sources are under evaluation.



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Mutual Gains

Zucca says the growing number of partnerships between Livermore, former Russian nuclear weapons workers, and, in many cases, American companies has shown that the two programs have been successful in growing businesses in the FSU and providing new careers. The programs have helped foster an openness to change among Russian scientists, technicians, engineers, and government officials.

Both the West and Russia benefit, says Zucca. Russian weapons workers and institutes gain from commercial relationships with established U.S. private-industry firms and DOE national laboratories, exposure to Western commercial business practices, and employment and income opportunities in nonmilitary high-technology fields. Livermore scientists are learning from their foreign counterparts, as well. For example, they are learning new manufacturing and welding techniques, such as superplastic forming, which deforms metal as if it were plastic or glass. Livermore researchers are also learning about Russian technology to detect explosives.

"Good things are happening," says Zucca. The payoff is increased international security.

— Arnie Heller

Key Words: Federal Atomic Energy Agency, former Soviet Union (FSU), Initiatives for Proliferation Prevention (IPP), nonproliferation, Nuclear Cities Initiative (NCI), Proliferation and Terrorism Prevention Program, Russian Ministry of Atomic Energy, Russian Transition Initiatives.

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